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STUDY EXPERIMENTAL PERFORMANCE IMPROVEMENT OF VARIOUS STOVES WITH ADDITING ONE ALUMINUM CYLINDER

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ABSTRACT

This study aims to make coconut shell charcoal briquettes as stove fuel, to conduct the proximate, heating value and to test the performance of temperature, water boiling ability and the efficiency of three types of stoves before and after modification. The method used is an experimental method by utilizing waste coconut shell charcoal briquettes as stove fuel on three different types before and after modification. The results of combustion tests on three different types of stoves before and after modification indicated that the stove burners K'1 were one types (codes) of the most superior briquette stove in terms of the boiling ability and modifications to suit the combustion efficiency (K'1 for 71.30 %)

Keywords: coconut shell charcoal briquettes, calorific value, physical property, and stove efficiency.

INTRODUCTION

Energy consumption is increasing day by day in line with the increasing population growth rate. So that the impact of this is a prolonged economic crisis, because the amount of energy needed is increasingly limited. It appears that conditions changed drastically when the fuel subsidy was gradually eliminated. Several layers of society, not only the lower and middle classes, but also the domestic industry, are starting to feel the burden of removing fuel subsidies. Facts and data show that the use of fossil fuels is running low because oil reserves are running low. High oil prices are volatile and continue to rise. The issue that fossil fuels cause environmental damage is beginning to be proven. Along with the increasing world population growth, people are motivated to seek new alternative energy sources by utilizing renewable energy sources. One of the renewable energies that is widely used comes from biomass in agriculture, especially coconut fruit waste, namely coconut shells. Coconut shell charcoal is a product obtained from burning coconut shells. Charcoal provides higher heat and less smoke and can be pulverized and then compressed into briquettes in various forms, where the use of briquettes will be more practical, efficient and economical and easy to obtain compared to firewood.

There are several previous studies that used coconut shell as fuel for briquettes, namely [1] producing a calorific value of 5839.33 cal/gr, [2] producing a coconut shell calorific value of 4949 cal/gr.

Based on the above considerations, biomass energy in the form of coconut shell briquettes is used as fuel in various briquette stoves. The modification is to improve performance in increasing the effectiveness and efficiency of alternative fuels to ease the burden on the government, especially for people who have difficulty finding kerosene. The existence of previous research has also modified the stove, namely [3] modifying the stove to produce a thermal efficiency of 22.08% and [4] doing a stove design to produce a thermal efficiency of 26.5%, a flame temperature of 736°C. and low emissions. [2]a modified the stove with the addition of one row of holes above, resulting in a thermal efficiency of 70% of the stove, [5] producing a thermal efficiency by modifying the stove 68% by modifying the stove. [6] performed the modification with Up and down grate on the clay stove resulting in a thermal efficiency of 54.12%.

Therefore, it is necessary to study the possibility of improving the performance of various biomass briquette-fueled stoves to reduce dependence on petroleum, especially kerosene, and to seek more economical alternative energy.

LITERATURE REVIEW

Briquette stove a cooking appliance that uses fuel from briquette, which was a solid material that has been processed either with or without carbonization process derived from coal biomass or the like. Nowadays, the use of briquette is not unfamiliar anymore, because of the recommendation of government to diversify energy. Moreover, Indonesia's coal reserves were very abundant, as well as biomass. Materials used in producing the stove affect the appearance, durability, and quality of heat utilization. The types consist of:

a) Britubara Stove (briquette-coal) is one type of stoves which are coated with flame-retardant materials and heat resistant. However, if it is not carefully used, it will be easily broken and it can not be used anymore. Hereinafter referred to as K1 stove.
b) KM stove is a stove briquette made of durable metal material, but is not stainless so the appearance changes along with the duration of use. Hereinafter referred to as K2 stove.
c) Clay oven or is commonly called brazier, is made of pottery raw materials, such as burnt clay, is widely available in the community and is generally used

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mostly in rural communities. Hereinafter referred to as K3 stove

The testing consisted of two parts: briquette burning/water boiling and calculations efficiency (η_{th}):

$$\eta_{th} = \frac{Q_w + Qp}{LHV \ x \ Mbb} \ldots(1)$$

$$\eta_{th} = \frac{(Ma \ x \ Cp_{air} \ x \ (T_a - T_b)) + (M_p x Cp_{al} x (T_c - T_b)) + (Mu \ x \ Hl)}{LHV \ x \ Mbb} \ldots(2)$$

where:

η_{th} : thermal efficiency of briquette burning (%).
M_a : initial water mass (kg),
M_{bb} : remaining briquette mass in the stove (kg).
M_u : mass of water vapor (kg).
H_L : vapor latent heat (kJ/kg).
Cp_{air} : water specific heat 4.1769(kJ/kg ^{0}C).
Cp_{al} : aluminum/pot material specific heat (kJ/kg ^{0}C).
LHV : briquette lower heating value (kJ/kg).
T_b : water's ambient temperature
T_a : water vapor temperature (100 ^{0}C)
T_c : POT temperature (^{0}C)

MATERIAL AND METHODS

This study was conducted between April until Mei 2018 with a range of activities including: measuring the dimensional of the three stoves that would be modified, making coconut shell charcoal briquettes in the shape of a bee nest, proximate and heating value testing, physical property testing as well as water boiling testing and briquette combustion on three different stove before and after modification with additing one cylinder aluminium. The modification efforts intended to improve the stove cooking time and their effiency by getting a high temperature and to minimize heat loss.

Stove code testing which was used before and after modification in various briquette stove could be seen in Table-1 below:

Table-1. Stove's codes which are observed.

No	Stove's Codes	Stand-for	Notes
1.	K1	Britubara (charcoal-briquette) stove	Britubara stove
2.	K'1	Modification by additing with one cylinder.	
3	K3	Stove/clay oven	Stove/clay oven
4	K'3	Clay oven by additing one cylinder	

RESULTS AND DISCUSSIONS

Briquettes produced had average diameter dimension of (d) = 65 mm, high (t) = 45 mm, hole in the center hole (d_1) = 15 mm and around (d_2) = 8 mm (four holes).

a. Combustion Efficiency

Example for thermal efficiency calculation was for K1 stove boiling water for 2 times with maximum flame temperature of 309 ^{o}C with briquette burning time for 240 minutes (4 hours), and spending briquette 0.22 kg. Furthermore, the data could be seen as follows:
Calculation efficiency was:

$$\eta_{th} = \frac{(0.8x4.1769x(2x(100-31)+(96-34))+0.18x0.9x((309-31)+(240-31)+(225-34))+(2256.487x0.08)}{0.22x(17479.48)}$$

$$\eta_{th} = \frac{958.65896}{3845.4896} x100\% = 24.96\%$$

The comparison of the three types of stoves data testing before and after modification in water boiling ability, maximum flame temperature, and thermal efficiency of the burnt-out briquettes presented in the Table-2 below.

Table-2. Tabulation of stove performance improvement.

Various Stoves	Thermal Eficiency (%)		Fuel Temperature (oC)		Boiling Time (Minute)	
	With Cilinder	Without Silinder	With Cilinder	Without Cilinder	With Cilinder	Without Silinder
K1	71.3	24.96	393	309	24	48
K2	-	36.69	-	451	-	39
K3	70.73	15.07	373	255	27	83

K1 stove before modification(without cylinder) had maximum thermal efficiency, burnt-out briquette mass, water boiling time, respectively as: 24.96%, 309 ^{o}C, 48th and After modification of K'1, the maximum flame temperature was 393 ^{o}C, 24th and efficiency 71.30%. K2 stove before modification was respectively 451^{o}C, 3 times within 215 minutes and efficiency 36.69 %. K3 stove before modification produced 255^{o}C, 83th, and 15.07%. K'3 stove after modification was27 minutes, 373^{o}C, and 70.73 %.

Briquette combustion data test by using water boiling method for three types of stove before and after modification were collected every 5 minutes, i.e. flame temperature, water temperature, water mass, briquette mass before, after combustion, and vapor mass. The data are presented in Figure 1 to 5.

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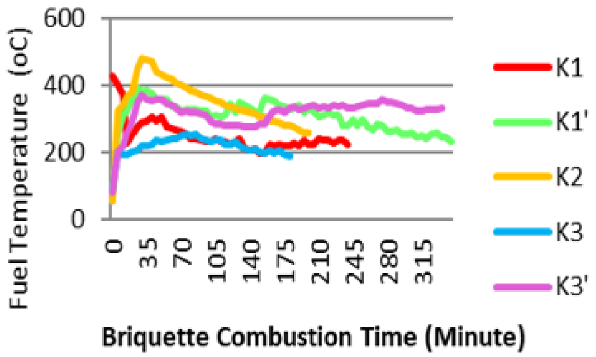

Figure-1. Graph relation of briquette combustion time to fuel temperature.

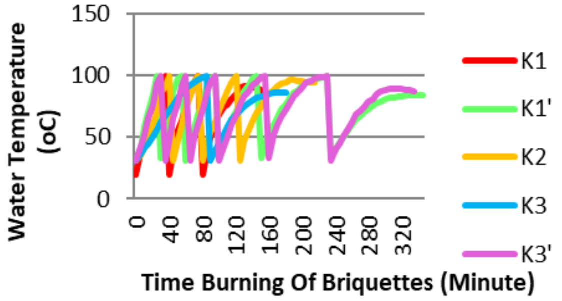

Figure-2. Graph relation of fuel combustion time to water temperature.

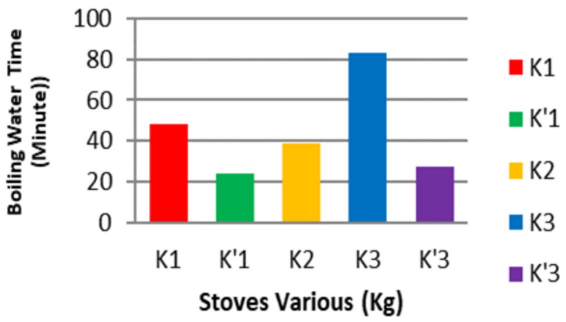

Figure-3. Graph of stoves various vs boiling time.

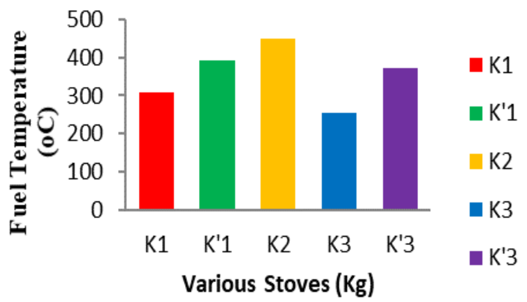

Figure-4. Graph of stoves various vs fuel temperature.

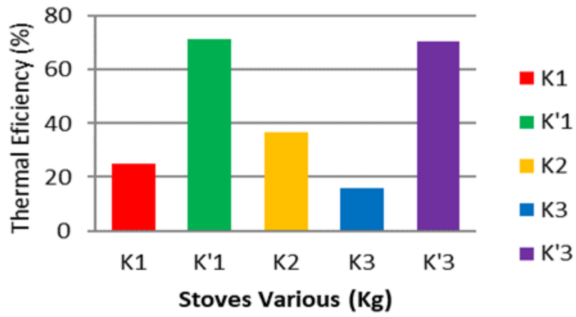

Figure-5. Graph of stoves various vs thermal eficiency.

Figure-1 was a graph of relationship between Fuel temperature and briquette combustion time before and after modification. It could be seen in the Figure-6 that K2 Stove very high maximum Flame temperatur was 451 ^{o}C than other stoves.

Figure-2 was a graph of relationship between briquette combustion time to water temperatur That K1' stove and K3 stove after modification is the best. It could be seen in the Figure-8 that water boiling abilitys 5 times of K1' and K3 stove

Figure-3 was graph relationship between stoves various and boiling time before and after modification wit additing one cylinder one rows up that K'1 stove have time very quickly from any others is 24th.

Figure-4 was graph relationship between stoves various and fuel temperatur before and after modification with additing one cylinder rows up that K2 very higher fuel is 415^{o}C.

Figure-5 was graph relationship between stoves various and boiling time before and after modification wit additing one cylinder one rows up that K'1 stove have thermal eficiency very good is 71,3 %.

K1 stove before modification only two times water boiling with maximum temperature of 309^{o}C and efficiency 24.92%. And after the modification, K'1 stove's water boiling had suffered almost as many as 5 times with temperature of 393^{o}C, efficiency was 71.30%. This was because the addition of a modified aluminium cylinder plate hole above the line that was able to maintain the briquette's fire heat for almost more than 5 hours.

K2 stove before modification produces 3 times water boiling with temperature of 451^{o}C and efficiency of 36.69%.

K3 stove before modification only boiling the water one time with flame temperature of 255 ^{o}C and efficiency 15.70 %. After modification of K'1 stove, water boiling ability was obtained 5 times with not too high temperature of 373 ^{o}C and efficiency of 70.73%. This was due to the additional modification of one top row aluminum cylinder plate which was also able to sustain the flame briquette for 335 minutes.

CONCLUSIONS

Result Burning test on stove got highest thermal efisiensi after additing cylinder aluminium on K1’ stove by 71, 3 %, then K3’ stove by 70,73 %. K2 stove is superior in terms of maximum flame temperature 451 ºC. Boiling water time is the on K1’ by 24 minutes faster than.

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